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Turbulence Decay and Restratification in the Equatorial Ocean Surface Layer following Nighttime Convection

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ABSTRACT

Although the process of restratification of the ocean surface layer at the equator following nighttime convection is similar in many ways to the process at midlatitudes, there are important differences. A composite day calculated from 15 days of consistent conditions at 140°W on the equator was compared with midlatitude observations by Brainerd and Gregg. In the depth range of 20–40 m, 1) minimum nighttime stratification was similar [N^2 of 1.2–3.2 ($\times 10^{-6}$ s^{-2}) vs 0.4–1.7 ($\times 10^{-6}$ s^{-2})], 2) maximum daytime stratification was significantly larger, as might be expected from the greater surface heat input [N^2 of 8–21 ($\times 10^{-6}$ s^{-2} vs 3–7 ($\times 10^{-6}$ s^{-2})], and 3) minimum nighttime shear was similar [shear-squared was 1.4–4.6 ($\times 10^{-6}$ s^{-2}) vs 0.8–1.9 ($\times 10^{-6}$ s^{-2})], but the maximum daytime shear was much larger [shear-squared of 24–41 ($\times 10^{-6}$ s^{-2}) vs 3–7 ($\times 10^{-6}$ s^{-2})].

For much of the surface layer, the dominant identifiable cause of restratification in both cases was the divergence of the penetrating shortwave radiation,

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although at the equator the divergence of turbulent flux was important from 10 to 25 m. In both cases the divergence of vertical fluxes accounted for only 60%–70% of the restratification; relaxation of lateral gradients was probably the source for the rest. At the equator, the shear in the upper 40 m was restored in the daytime by turbulent transport of momentum injected by the wind.

In the region convectively mixed at night, turbulence decayed exponentially in the daytime in both cases, the *e*-folding time, τ_{ε}, being 1.7 ± 0.2 h at the equator, 1.5 h in midlatitude. A dimensionless decay time, $N\tau_{\varepsilon}$, was 7.2–9.3 compared with 6.0 in the midlatitude case. In both cases the vertical scale of the turbulence was controlled by the Ozmidov scale, and the turbulence remained active throughout the day.

At the equator "deep-cycle" nighttime turbulence was generated in the always-stratified water at depth 60–80 m never reached by nighttime convection. Neither shear nor stratification varied significantly diurnally. The decay of this turbulence was similar to that above in that its vertical scale was controlled by the Ozmidov scale and remained active throughout the day, but the *e*-folding timescale was much longer, 3.5 h ($N\tau_{\varepsilon}$ = 66–96). For the turbulence to persist this long, turbulence production must be a large proportion of ε.

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